

CLAIMS

1. Treatment planning apparatus for an orthodontic patient, comprising:
a workstation having a processing unit and a display;
a memory storing a virtual three-dimensional model of teeth and/or associated anatomical structures representing the dentition of a patient; and
5 software executable by said processing unit to access said model and display said model on said display;
said software further including navigation tools enabling a user to interactively manipulate said model on said display and simulate the movement of at least one tooth in said model relative to other teeth in said model.
2. The apparatus of claim 1, further comprising:
a library of virtual, three-dimensional orthodontic brackets, said software permitting a user to access said virtual brackets, place said virtual brackets on said virtual model of the dentition of the patient, and simultaneously display both said virtual brackets and said virtual model.
3. The apparatus of claim 1, wherein said virtual model of teeth comprises a set of virtual, individual three-dimensional tooth objects and wherein individual ones of said virtual tooth objects can be individually selected and moved relative to other teeth in said set of virtual tooth objects.

4. The apparatus of claim 1, wherein said virtual model comprises a set of virtual, individual three-dimensional tooth objects and wherein said software enables a user of said workstation to select an archform for said virtual model, wherein said set of tooth objects are moved with respect to said archform.

5. The apparatus of claim 1, wherein said virtual model comprises a set of virtual, individual three-dimensional tooth objects and wherein said set of tooth objects are moved with respect to each other to define an archform representing, at least in part, a proposed treatment for the patient.

6. The apparatus of claim 4 or claim 5, wherein said software displays a screen permitting a user to modify the position of said individual tooth objects with respect to said at least one of the following: said archform, associated anatomical structures, and other teeth.

7. The apparatus of claim 4 or claim 5, wherein said software displays a screen permitting a user to customize the shape of said archform.

8. The apparatus of one of claims 3-5, wherein said virtual tooth objects are obtained by software comparing said virtual model of teeth with a set of virtual three-dimensional template teeth.

9. The apparatus of one of claims 3-5, further comprising a second computer remotely located from said workstation, wherein said virtual tooth objects are obtained by software

comparing said virtual model of teeth with a set of virtual three-dimensional template teeth, and wherein said software performing said comparing is performed by said second computer.

10. The apparatus of claim 2, wherein said software displays an independent virtual three-dimensional object representing an orthodontic archwire, said archwire and orthodontic brackets representing a prospective appliance for treatment for said patient to move the patient's teeth to a target situation.

11. The apparatus of claim 1, wherein said software simulates the movement of teeth from an observed, present situation of said dentition to a target situation for said dentition reflecting a prospective treatment of said patient.

12. The apparatus of claim 1, further comprising:

a scanning system for scanning of the dentition of the patient or a model of the dentition, said scanning system further comprising software for processing captured images from said scanning system and converting said captured images into said virtual model of the dentition.

13. The apparatus of claim 12, wherein said scanning system further comprises a hand-held scanner adapted for intra-oral, in-vivo scanning of a human patient.

14. A method of digital treatment planning for an orthodontic patient on a workstation having a processing unit, a user interface including a display and software executable by said processing unit, comprising the steps of:

obtaining and storing a three-dimensional virtual model of teeth representing the dentition of the patient in a current situation;

displaying the virtual model on the display;

moving the position of teeth in the virtual model relative to each other so as to place the teeth of the virtual model into a target situation; and

displaying the virtual model with the teeth moved to the target situation;

whereby parameters for an orthodontic appliance to move the patient's teeth from the current situation to the target situation can be derived from the virtual model and/or the target situation.

15. The method of claim 14, further comprising the step of providing screen displays on said display enabling a user of the workstation to operate the user interface so as to place virtual three-dimensional objects representing an orthodontic appliance onto the surface of teeth in said virtual model.

16. The method of claim 15, further comprising the step of providing screen displays on said display enabling a user to change the position of said orthodontic appliance relative to said teeth.

17. The method of claim 15, wherein said orthodontic appliances comprises brackets and an archwire, and wherein the method further comprises the step of displaying on the display a virtual three-dimensional object representing said archwire, said archwire passing through slots of said brackets.

18. The method of claim 14, wherein the orthodontic appliance comprises a retainer.
19. The method of claim 14, wherein said orthodontic appliance comprises an archwire.
20. The method of claim 15, wherein the orthodontic appliance comprises a set of brackets, location information for said brackets relative to teeth in said virtual model, and an archwire.
21. The method of claim 14, wherein said orthodontic appliance comprises a removable orthodontic appliance.
22. The method of claim 14, further comprising the step of determining whether a collision of teeth occurs during the movement of the virtual model of the teeth from the current situation to the target situation.
23. The method of claim 14, further comprising the step of exporting the parameters for the orthodontic appliance to an appliance manufacturing facility and manufacturing the appliance from the exported parameters.
24. The method of claim 23, wherein said orthodontic appliance comprises an archwire.
25. The method of claim 23, wherein said orthodontic appliance comprises a removable orthodontic appliance.

26. The method of claim 14, further comprising the step of providing navigational tools on said display enabling a user to view said virtual model in either the target or the current situation in a cross-sectional clipping plane.

27. The method of claim 26, further comprising the step of providing a screen display enabling a user to select a desired archform for said virtual model.

28. The method of claim 27, wherein said screen display enables a user to change the shape of said arch form.

29. The method of claim 13, further comprising providing a measuring tool for measuring said virtual model.

30. An orthodontic workstation, comprising:

a processing unit and a display;

a memory storing a virtual three-dimensional model of teeth and/or associated anatomical structures representing either the dentition of a patient or a desired target situation for the dentition; and

software executable by said processing unit to access said model and display said model on said display;

said software further including a measurement tool enabling a user to measure in three planes of space the distance between two points on said virtual three dimensional model.

31. The workstation of claim 30, wherein said memory stores both a virtual three-dimensional model of the teeth and/or associated anatomical structures representing the dentition of a patient and a virtual three-dimensional model of a desired target situation for the patient.

32. The workstation of claim 30, wherein said memory further stores a virtual bracket template comprising a virtual three-dimensional model of a set of brackets as placed on the surface of the virtual three-dimensional model of the teeth and/or associated anatomical structures representing the dentition of a patient.

33. The workstation of claim 32, wherein said workstation receives data representing a scan of a patient having brackets placed on the surface of the teeth of the patient, and wherein said software enables a user to compare the location of brackets as placed on the surface of the teeth with said virtual bracket template and quantify differences between the actual placement and the virtual bracket template.

34. The workstation of claim 32, wherein said memory further stores an archwire template comprising a virtual three-dimensional model of an orthodontic archwire as placed on the surface of the virtual three-dimensional model of the teeth and/or associated anatomical structures representing the dentition of a patient.

35. The workstation of claim 34, wherein said workstation receives data representing a scan of a patient having an archwire placed on brackets bonded to the surface of the teeth of the patient, and wherein said software enables a user to compare the location of said archwire as

actually placed on the surface of the teeth with said archwire template and quantify differences between the actual placement and the archwire template.

36. The apparatus of claim 1, wherein the virtual model of the dentition includes upper and lower archforms representing the teeth of the upper and lower arches of the patient, and wherein the software enables a user to simulate changes in the placement of the upper archform relative to the lower archform.

37. The apparatus of claim 1, said software further including a measurement tool enabling a user to measure in three planes of space the distance between two points on said virtual three dimensional model.

38. The apparatus of claim 1, said software further comprising a zoom feature enabling a user to change the size of a tooth in the virtual model of the dentition.